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VANADIUM AND EXPERIMENTAL CARIES SECONDARY ACTION ON ORGANS AND TOXICITY

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VANADIUM AND EXPERIMENTAL CARIES

SECONDARY ACTION ON ORGANS AND TOXICITY

(Vanadio e carie sperimentale
Azioni secondarie sugli incrementi ponderali e tossicata)

by

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In the course of experimenting on the cariosprophylactic activity of vanadium in golden hamsters, the authors also took into account the possibility of pathological phenomena induced in organs and systems. On the basis of the experimental results it is to be inferred that vanadium administered in proper doses with drinking water does not interfere with growth nor, in contrast to what has been observed by other researchers, does it induce macro- or microscopic lesions in such organs as the liver and the kidneys, which regulate the absorption and elimination of vanadium.

In considering the particular action of a trace element -- in the present case, the caries inhibiting action of vanadium --

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we must always take into account all the other effects -- positive as well as negative -- to which the element may give rise in the course of its metabolism lest we succeed in preventing local damage only at the expense of damage of a general order. This is because of the ignorance that still prevails as regards the physiological behavior of such elements, which exert their beneficial influence on the economy of living organisms only if they are administered in small doses.

As a matter of fact, in many cases experiments have shown that if the recommended doses are even slightly exceeded, or if the element is administered for too long a time, or if phenomena of retention and accumulation are caused by the aforesaid conditions or other adverse events, true poisoning of a chronic nature may be induced.

Depending on whether it affects individual organs or systems or involves the organism as a whole, this poisoning can be evinced in different ways. The first case may lead to malfunctioning of the nobler parenchymata that regulate the absorption -- liver -- or elimination -- kidneys -- of the tested element. In the second case often the only parameter that can be measured is the growth rate, which may evince a slowing down or stasis much before the poisoning is revealed with the clear symptomatology of a true pathological state.

On the basis of these considerations, in the course of our experiments on the carioprophylactic activity of vanadium we deemed it indispensable to check for the possible secondary

actions that this element, in the doses and for the length of time we adopted, might have on the experimental animals; the data to be found in the literature in this connection are scanty as well as contradictory and refer for the most part to experiments on rats.

Franke and Moxon (1936-37) (1-2), in determining the toxicity of vanadium administered to rats by way of their food and taking as principles of evaluation the consumption of food and the effect on hemopoiesis and mortality, place vanadium right after selenium in decreasing order of toxicity and fix at 25 ppm the dose at which the first phenomena of a pathological order put in an appearance. Daniel and Lillie (1938) (3) demonstrate that rats receiving in their diet 11.5 and 22 ppm of V as sodium metavanadate for a period of 12 weeks display no symptom of suffering.

On the other hand Munler (1957) (4), administering to two groups of rats vanadic anhydride in total doses of 40 and 20 ppm respectively and for 140 days of experiment, observed in his subjects the inception of vanadium poisoning and a loss of bodily weight. Messina (1958) (5), in experiments with hamsters to which vanadium was administered parenterally in the form of V_2O_5 in aqueous solution, reports that this treatment does not inhibit normal growth.

On the other hand Pappalardo (1959) (6), in rats that received daily 0.5 ml of a solution with 1% of sodium metavanadate, demonstrated that already on the 24th day of the experiment the

thusly treated subjects had gained less weight than the control animals. Histological examinations of the liver, kidneys and spleen, in the course of experiments by Lutomska and Pawlak (1960) (7) on golden hamsters, revealed that vanadium, molybdenum and fluorine administered individually and by way of drinking water or parenterally, do not cause any changes of this sort. Only when the three elements are combined do degenerative phenomena occur in the hepatic parenchyma and renal tubules. Lutomska, Pawlak and Gruszczyska (8) found slight renal and hepatic damage only with toxic doses of 0.50 mg/100 ml, after about 7 weeks, when the organism had received 8 mg of vanadium on the whole.

As can be seen from examination of the literature under discussion, if the few available data indicate, on the one hand, that the reaction of the rat is different from that of the hamster, they do not, on the other, constitute further and conclusive experimental contributions to the solution of the problem.

Therefore in the course of our experiments we paid particular attention to the seconday effects that might be manifested during oral administration of vanadium, and it is on these results that we are reporting in the present note.

Methods and materials

We set up three groups of golden hamsters, each group consisting of 10 male subjects of the same age and average weight, subdivided as follows:

Group 1: subjects receiving the cariogenic diet of Keyes and normal water (control group);

Group 1: subjects receiving the cariogenic diet of Keyes and drinking water containing 5.5 ppm of V;

Group 3: subjects receiving the cariogenic diet of Keyes and drinking water containing 11.0 ppm of V.

The test was prolonged for 90 days during which the increases in weight of the subjects in the different groups were checked by individual weighings carried out every 10 days. The chemical composition in percent of the cariogenic diet referred to a normal diet for hamsters can be seen from the following table:

TABLE

	Cariogenic diet of Keyes	Normal diet
moisture	7.80%	10.18%
crude proteins	14.34%	20.84%
crude lipids	6.38%	3.80%
crude fiber	3.70%	4.94%
ashes	3.42%	5.56%
nitrogenated extracts	72.16%	64.86%

The disequilibrium between the two diets is evident, especially as regards protein content and the percentage of nitrogenated extracts and ashes which, for the purpose of evaluating the increases in weight, cannot be compared with the growth standards that are characteristic of the animal species in question; only an intergroup comparison is possible.

At the end of the experiment we sacrificed six subjects

per group for the caries count. Then we carried out an anatomicopathologic examination and prepared histologic sections from liver and kidney samples.

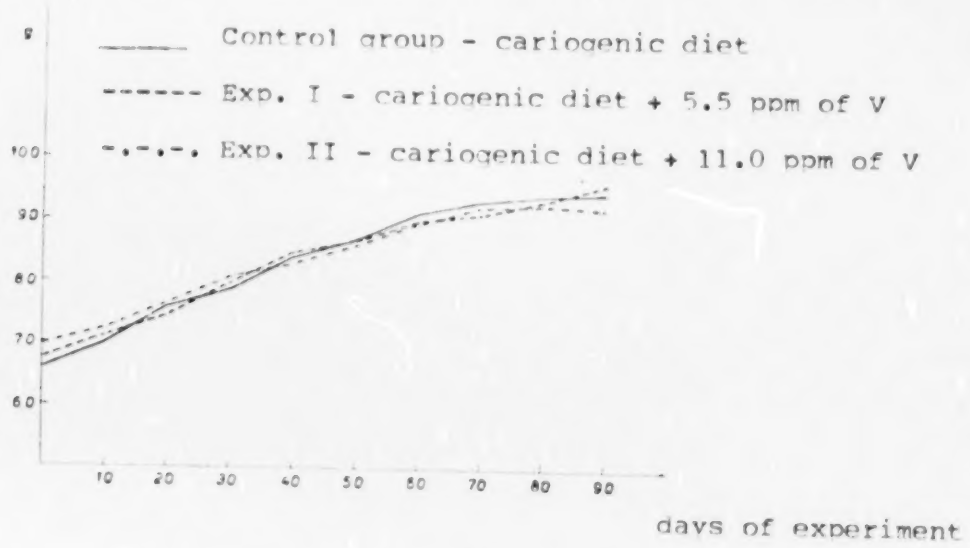

Fig. 1

Results and discussion

The weight increase curves (fig 1) show no appreciable differences for the three groups of animals in question. The finding of lower values than the standard for the species is surely to be attributed only to the protein deficiency as compared with the recommended values.

The anatomicopathologic examination carried out on subjects sacrificed at the end of the experiment enabled us to exclude the presence of macroscopically noticeable lesions. The histologic sections prepared from the livers of subjects from both experimental groups (Figs. 2 and 3) do not differ from those of the control subjects nor do they disclose degen-

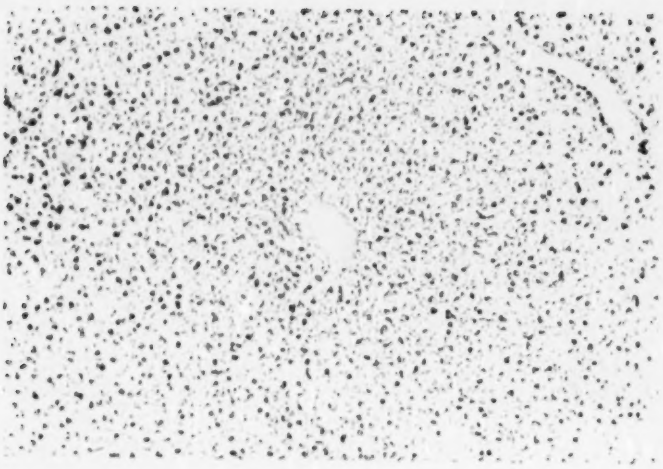

Fig. 2. Liver of hamster treated with 11.0 ppm of V by oral administration for 90 days. No changes to be detected.

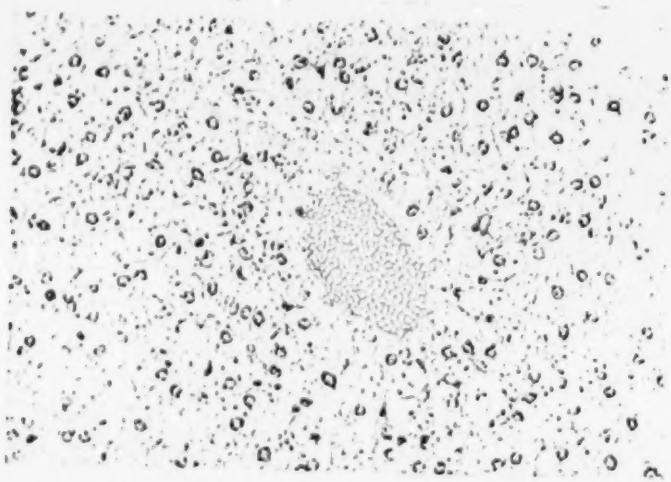

Fig. 3. Detail of the preceding figure. The specimen is normal.

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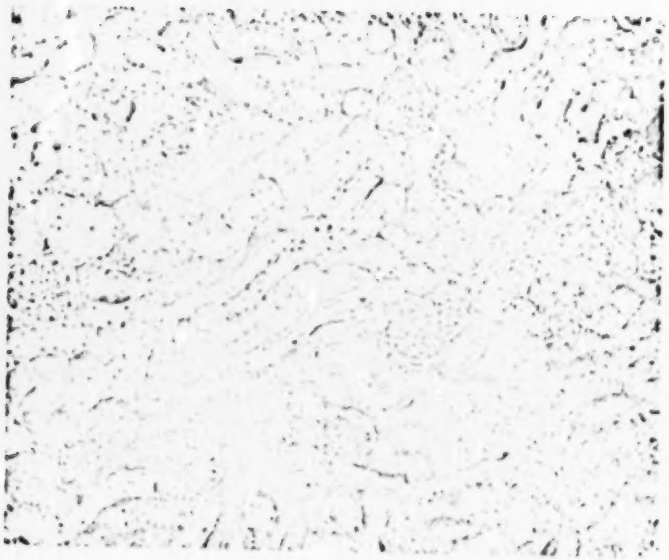

Fig. 4. Kidney of hamster treated with 11.0 ppm of V by oral administration for 90 days. Absence of changes in glomerules and tubules.

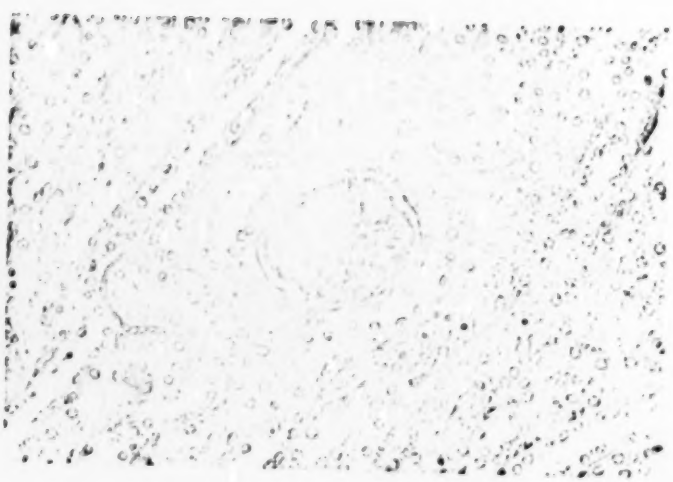

Fig. 5. Detail of Fig. 4. Evident is the normal structure of a glomerule and of the tubules.

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erative phenomena of the fatty type or other modifications of a pathologic order. The renal parenchyma (Fig. 4) too, which, in this case, should be the most to feel the effects of V since on it is incumbent the task of eliminating excess quantities, is perfectly normal. In contrast to what has been noted by other authors, the renal tubules (Fig. 5) have neither glamerular lesions with consequent passage of erythrocytes into their lumen nor cellular degeneration with defective coloration and pyknosis of the nuclei.

On the basis of these results we can therefore conclude that oral administration of vanadium with drinking water for a period of 90 days, in the respective doses of 5.5 ppm and 11.0 ppm, does not lead to phenomena of a pathological order either for the organism as a whole or for the organs and systems that regulate its absorption and elimination, while the same tested doses of this element do lead to a significant reduction in caries experimentally induced in the hamster. To sum up: Absence of toxic phenomenology and concomitant beneficial effect in caries prevention.

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